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AUTHOR	DeVries, Rheta
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ABSTRACT

The relative effects of chronological age, mental age, IQ or Piagetian task performance were investigated among 143 Ss of high, average, and low IQ. Two kinds of group comparisons were made on fifteen tasks: (1) groups of the same chronological age, but different mental age and IQ, and (2) groups of the same mental age, but different chronological age and IQ. Results indicated that children of higher IQ develop through Piagetian stages faster than children of lower IQ, and that high IQ children tend to think in a more preoperational way than older children of the same mental age but lower IQ. Implications of the study suggest that it is dangerous to limit the assessment of intellectual development to traditional psychometric methods; Piagetian methods offer an important source of very different information about an individual's intellectual development. (SBT)

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ABSTRACT

Relative effects of chronological age, mental age, and IQ on Piagetian task performance were investigated among 143 Ss of High, Average and Low IQ. Two kinds of group comparisons were made on fifteen tasks: 1) groups of the same chronological age, but different mental age and IQ, and 2) groups of the same mental age, but different chronological age and IQ. Results indicated that children of higher IQ develop through Piagetian stages faster than children of lower IQ, and that High-IQ children tend to think in a more preoperational way than older children of the same mental age but lower IQ.

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Performance on Piaget-Type Tasks of High-IQ,[1] Average-IQ, and Low-IQ Children

Rheta DeVries

University of Illinois at Chicago Circle

This study addresses itself to the issue raised by contradictory findings concerning the relationship between psychometric and Piagetian assessments of intellectual development. On the one hand, several factor-analytic studies (Kohlberg and DeVries, 1969; DeVries, 1971; Stephens, McLaughlin, Miller, and Glass, 1972; Stephens, 1972; Hathaway, 1973) indicate that psychometric and Piagetian methods of assessing intellectual development overlap somewhat, but to a large extent, tap different aspects of cognitive functioning. On the other hand, studies comparing radically different IQ groups on Piagetian tasks show that High-IQ children outperform Average-IQ children (Kohlberg, 1963; Goodnow and Bethon, 1966) who, in turn, outperform Low-IQ children (Inhelder, 1943; Stephens, 1972). The latter findings suggest that the two assessments of intelligence are much more closely related than the factor-analytic findings suggest.

One way of trying to resolve this contradiction is to compare groups radically different in IQ but comparable in terms of psychometric mental age (MA). The expectation would be that if the two kinds of assessments are actually reflecting the same intelligence, groups of comparable MA would perform at the same level on Piagetian tasks. Several studies provide evidence of this type, but the findings are conflicting. Goodnow and Bethon (1966) found no differences in performance on Piagetian conservation tasks among bright, average, and retarded groups, all mentally aged 8. In contrast, Feigenbaum (1963) found younger children with higher IQ to be superior to older, duller children. However, other studies (Russell, Dennis, and Ash, 1940; Granich, 1945; Brown, 1973) indicate that higher-IQ children are inferior on Piagetian tasks to older, lower-IQ children of the same mental age.

Still another approach to the problem is to compare the different IQ groups on the average age at which they pass Piagetian tasks. Hood (1962) found 50 percent of a group of Average-IQ children to succeed on number-related tasks at MA 7-1 years, while the 50 percent level of success was not reached by a Low-IQ group until MA 8-8 years. Stephens (1972) considered a much larger number of tasks and Ss in a longitudinal study. She found the MA at which 50 percent of Average and Low-IQ Ss passed to be equal for two Piagetian variables, earlier for the retarded on four variables, and earlier for the Average-IQ Ss on twelve variables.

The purpose of the present study is to provide additional evidence bearing on the issue of the relationship between psychometric and Piagetian methods of assessing intellectual development. More specifically, the aim is to investigate the relative effects of chronological age, mental age, and IQ on Piagetian task performance.

Method

Ss were 143 bright, average, and retarded children, as defined by their performance on the Stanford-Binet Intelligence Scale. Bright and average children were chronologically 5 to 7 years of age. Retarded children were mentally aged 5 to 7 years, and chronologically aged 6 to 12 years. The distribution and characteristics of the sample, and Guttman scaling of tasks used, are described elsewhere (DeVries, 1970, 1971, 1973).

Ss were administered the following battery of 15 Piaget-type tasks.[2]

Guessing Game (DeVries, 1970)

Conservation of Mass

Sibling Egocentrism

Left-Right Perspective

Constancy of Generic Identity (revised photograph form of the test described in DeVries, 1969)

Class Inclusion

Conservation of Number

Constancy of Sex Identity (Kohlberg, 1963; DeVries, 1969)

Conservation of Mass in the context of the ring-segment illusion (Jastrow effect)

Dream Interview

Conservation of Length

Length Transitivity

Conservation of Liquid

Magic Interview (Kohlberg, 1963)

Object Sorting (Kohlberg, 1953)

Analysis

In order to find out whether performance on Piagetian tasks could be predicted by psychometric performance, the following two kinds of group comparisons were made of mean scale scores:

1. Groups of the same chronological age, but different mental age and IQ:
   Analysis of variance of High-IQ vs. Average-IQ groups.
2. Groups of the same mental age, but different chronological age and IQ:
   a. Analyses of variance of Average-IQ vs. Low-IQ groups
   b. t-tests of differences between High-IQ and Low-IQ groups (both having mental ages of about 7 years)

Results

Comparison of mean scale scores on the 15 Piagetian tasks showed that High-IQ children outperformed Average-IQ children of the same chronological age on all tasks except Sorting (which did not differentiate among any groups in this study). (For the

details of these comparisons, see DeVries, 1971.) The IQ column in Table 1 shows that these differences are statistically significant for all tasks except Conservation of Mass, Left-Right Perspective, and Sorting. These findings support the notion that Piagetian and psychometric assessments are closely related.

INSERT TABLE 1 ABOUT HERE

In Table 2 the results of analysis of variance of scale scores for Average-IQ and Low-IQ groups indicate that when mental age was comparable, average

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INSERT TABLE 2 ABOUT HERE

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and retarded groups were not significantly different on 13 of the 15 Piaget-type tasks. Only on the Guessing Game did the Average-IQ group prove superior to the Low-IQ group. On the Sex Identity task, the retarded group was superior to the average group. These findings also generally support the notion that Piagetian and psychometric assessments are closely related.

Table 3 presents the results of comparing High- and Low-IQ groups comparable in mental age (High-IQ mean MA=7-2 years, Low-IQ mean MA=7-6 years).

INSERT TABLE 3 ABOUT HERE

The Low-IQ group was superior by at least one scale item in mean performance on eight tasks (Conservation of Mass, Length, Liquid, Sex and Genric Identity, Magic, Dream, and Left-Right Perspective). The High-IQ group was superior on four tasks (Number Conservation, Sibling Egocentrism, Guessing Game, and Sorting). On three tasks, performance was identical (Ring Segment, Class Inclusion, and Transitivity). For

a smaller sample of 3 Ss in each group where the MA's were more nearly identical (High-IQ mean MA=7-4 years, Low-IQ mean MA=7-5 years), the results were essentially the same, with only Transitivity moving to the High-IQ column. Because of the large variance in both groups, only two of these differences were statistically significant. The Low-IQ group was significantly higher on the Magic Task ($t=4.71$, 23 df, $p < .001$, for equated MA sample) and the High-IQ group was significantly higher on the Guessing Game ($t=2.31$, 24 df, $p < .05$, for equated MA sample). These findings contradict the notion that Piagetian and psychometric assessments are closely related, though the contradiciton is not strong, due to the lack of significant differences for most tasks.

Since the Low-IQ group was higher in mean MA, one might conclude that this difference accounted for the trend toward superiority. In order to explore further this possibility, the High-IQ group was compared with the Low-IQ group which was lower in MA. When the High-IQ group (MA=7-2 years) was compared with the Low-IQ group (MA of 6-5 years), the Low-IQ group was superior (but these differences were not statistically significant) on five tasks (Sex Identity, Magic, Left-Right Perspective, Sorting, and Class Inclusion). The High-IQ group was superior on six tasks (Conservation of Mass, Number, Liquid, and Ring Segment, and Sibling Egocentrism, and Dream), and the two groups performed equally well on four tasks (Guessing Game, Conservation of Length, Generic Identity, and Transitivity). The High-IQ group's nine-month advantage in mental age was not associated with similar clear-cut superiority on Piaget-type tasks. This finding supports the notion that Piagetian and psychometric assessments are not so closely related.

Similarly, High-IQ children (mean MA=7-2 years) were compared with Average-IQ children (mean MA=6-10 years), the four-month advantage in MA did the High-IQ group little good. The Average group did better on seven tasks (Conservation of Mass, Length, and Liquid, Magic, Left-Right Perspective, Sorting, and Guessing

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Game). The two groups performed equally well on four tasks (Sex and Generic Identity, Dream, and Class Inclusion). The High-IQ group was superior on only four tasks (Sibling Egocentrism, Transitivity, and Conservation of Number and Ring Segment. This finding also contradicts the notion that Piagetian and psychometric assessments are closely related.

Only when a 6-year-old, High-IQ group (mean MA=8-2 years) was compared with an Average-IQ 7-year-old group (mean MA=7-11 years) was the High-IQ group found to be clearly superior. They did better on eleven tasks (Conservation of Mass, Number, Length, Liquid, and Ring Segment, Sex and Generic Identity, Magic, Dream, Sibling Egocentrism, and Transitivity). On three tasks (Sorting, Class Inclusion, and Guessing Game), the two groups performed at essentially the same level, and on only one task (Left-Right Perspective) was the Average-IQ group superior. This finding clearly suggests that High-IQ children become concrete operational at an earlier age than Average-IQ children.

In summary, two results emerge:

1. Children of higher psychometric IQ develop through Piagetian stages faster than children of lower IQ.
2. Prior to the period of concrete operations, High-IQ children tend to think in a more preoperational way than older children of the same mental age but lower IQ.

Discussion

The comparisons between High-IQ groups and Low-IQ groups of equivalent or lower MA are somewhat equivocal, in light of the general lack of statistically significant differences. However, the finding of wide variance within each IQ group is in itself significant. It is clear that a given group with little variance in IQ and MA can vary a great deal in performance on Piaget-type tasks. This, together with the consistency of the older groups' superiority on more than half the tasks, and on one-third of the tasks when at a large disadvantage in MA, leads to a serious questioning of the assumption that psychometric and Piagetian tasks tap the same aspects of intelligence. It appears that children of the same psychometric mental age can perform at very different levels on Piagetian tasks, and children of higher IQ can perform at less advanced levels than children of lower IQ. The direction of these findings suggest that it would be fruitful to study the performance of larger groups more carefully matched in mental age, and using a Low-IQ group with less variance in chronological age (range here was from 8-9 to 12-5 years).

When the findings of this study are taken together with the findings of other studies, it appears that psychometric mental age predicts performance on Piagetian tasks only at certain developmental points in relation to Piaget's stages. Brown (1973) showed that at age 4 bright children tend on Piagetian tasks to be inferior to their (older) Lower-IQ mental-age-mates and more like their Average-IQ chronological-age-mates. At age 5 (according to the results of the present study), bright children are superior to Average-IQ CA-mates but tend to be inferior to Low-IQ MA-mates. By age 6, however, bright children are generally beginning to be concrete operational and have outdistanced both their Average-IQ CA-mates and MA-mates. At age 9, according to the Goodnow and Bethon (1966) study, bright childr outperform CA-mates but are equivalent to MA-mates. It appears that psychometric mental age is not a reliable predictor of Piagetian stage development, except in the general sense that brighter children become operational sooner.

Thus, the contradiction noted in the beginning of this paper between findings of factor-analytic studies and age-group comparisons of groups widely different in IQ turns out to be not a contradiction after all. Whether one finds higher-IQ children superior on Piagetian tasks to lower-IQ children depends on the chronological age one selects to study. At and below the age of 5 years, higher-IQ children tend to be more like their CA-mates on Piagetian tasks than their lower-IQ MA-mates. At 6 years of age, higher-IQ children surge ahead of their lower-IQ MA-mates when their reasoning becomes operational. Thus, it appears that the development of intelligence depends to a large extent to the length of a child's time on earth.

These studies particularly reflect the difference between Piagetian and psychometric conceptions of developmental rate. The psychometric conception is statistically defined as quantifiable and regular in relation to chronological age. For example, each correct answer on the Stanford-Binet Intelligence Test represents one month (up to the five-year level) or two months (beginning with the five-year level) of intellectual growth. In contrast, the Piagetian conception of developmental change is qualitative, and rate cannot, therefore, be quantified in terms of regular intervals. In fact, a finding of no change on a Piagetian task for an individual would not be taken to indicate lack of change in the individual's intellectual development. Moreover, poorer performance relative to other children at a young age would not, from the Piagetian point of view, preclude the eventual development of solid formal operational reasoning. Inhelder (1943) found that some children misclassified as retardates on IQ tests did attain formal reasoning, though at a slower rate than their age-mates.

It thus appears that Piagetian and psychometric methods assess two different intelligences. Psychometric assessment give us information about the degree to

which an individual has accumulated a store of correct answers to school-type questions. Piagetian assessment gives us information about the degree to which an individual has evolved in the construction of his knowledge and reasoning about reality.

The primary implication of this study (viewed in the context of other related studies) is that it is dangerous to limit our assessment of intellectual development to psychometric methods. Piagetian methods offer an important source of very different and perhaps more important information about an individual's intellectual development.

Footnotes

[1]This article is based on a paper presented at the annual meeting of the Society for Research in Child Development, April, 1973. The study was supported by the Department of Program Development for Gifted Children, Illinois Office of Public Instruction, with supplemental support provided by the Office of Education, U.S. Department of Health, Education, and Welfare through the Chicago Early Education Research Center, a component of the National Laboratory on Early Childhood Education, and by the Urban Education Research Program and the Research Board of the University of Illinois at Chicago Circle. Computing services used in this research were provided by the Computer Center of the University of Illinois at Chicago Circle. Their assistance is gratefully acknowledged. The author would like to thank Dr. Arthur Turner and other personnel of the Unit 4 Schools in Champaign, Illinois, for the many supportive services which facilitated the conduct of the study, and to thank the cooperating teachers, principals, and the children of Champaign, Urbana, and St. Joseph, Illinois. The author especially wishes to acknowledge the invaluable criticisms and suggestions of Dr. Constance Kamii and Dr. Lawrence Kohlberg on earlier drafts of this article. Author's address: College of Education, University of Illinois at Chicago Circle, Chicago, Illinois 60680

[2]The battery is referred to as "Piaget-type" because some tasks are included which Piaget never studied (Guessing Game, Constancy of Generic and Sex Identity, ring Segment Conservation, and Magic). Nevertheless, these were inspired by Piaget's work and are similar in focus and method to Genevan tasks. Tasks and scoring are described in detail elsewhere (DeVries, 1971).

TABLE 4

Analysis of Variance of High-IQ vs. Average-IQ Groups

Piaget-Type	IQ Group	SEX	AGE	SEX X CA	SEX X IQ Group	CA X IQ Group	SEX CA X IQ Group
Mass Conservation	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Number Conservation	.0001	N.S.	.02	.04	N.S.	N.S.	N.S.
Length Conservation	.003	N.S.	.0003	N.S.	N.S.	N.S.	N.S.
Liquid Conservation	.0007	N.S.	.002	N.S.	N.S.	N.S.	N.S.
Ring-Segment Conservation	.0001	N.S.	.0002	N.S.	N.S.	.05	N.S.
Sex-Role Identity	.0003	N.S.	.02	N.S.	N.S.	N.S.	N.S.
Generic Identity	.0001	N.S.	.05	N.S.	N.S.	N.S.	N.S.
Magic	.0001	N.S.	.0001	N.S.	N.S.	.002	N.S.
Dreams	.0001	N.S.	.0001	.02	N.S.	N.S.	N.S.
Left-Right Perspective	N.S.	N.S.	.0001	N.S.	.03	N.S.	.04
Sorting	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Class Inclusion	.0006	N.S.	.0001	N.S.	N.S.	N.S.	N.S.
Sibling Egocentrism	.0006	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Length Transitivity	.002	N.S.	.05	N.S.	N.S.	N.S.	N.S.
Guessing Game	.0001	N.S.	.0001	N.S.	N.S.	N.S.	N.S.

TABLE 2

Analysis of Variance of Average-IQ vs. Low-IQ Groups

Piaget-Type Task	IQ	SEX	AGE	SEX X IQ	SEX X IQ	CA X IQ	SEX CA X IQ
Mass Conservation	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Number Conservation	N.S.	N.S.	.03	N.S.	N.S.	N.S.	N.S.
Length Conservation	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Liquid Conservation	N.S.	N.S.	.008	N.S.	N.S.	N.S.	N.S.
Ring-Segment Conservation	N.S.	N.S.	.01	N.S.	N.S.	N.S.	N.S.
Sex-Role Identity	.03	N.S.	.05	N.S.	N.S.	N.S.	N.S.
Generic Identity	N.S.	N.S.	.03	N.S.	N.S.	N.S.	N.S.
Magic	N.S.	N.S.	.0009	N.S.	N.S.	N.S.	N.S.
Dreams	N.S.	N.S.	.0005	N.S.	N.S.	N.S.	N.S.
Left-Right Perspective	N.S.	.03	.001	N.S.	N.S.	.02	N.S.
Sorting	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Class Inclusion	N.S.	N.S.	.0001	N.S.	N.S.	N.S.	N.S.
Sibling Egocentrism	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Length Transitivity	N.S.	N.S.	.01	N.S.	N.S.	N.S.	N.S.
[illegible]	.005	N.S.	.0005	N.S.	N.S.	N.S.	N.S.

TABLE 3

Comparison of Several Mental-Age Groups on Piagetian Task Performance

Tasks on which High-IQ group superior	Tasks on which High-IQ and Low-IQ groups are equivalent	Tasks on which Low-IQ group superior
High-IQ, MA=7-2 years		Low-IQ, MA=7-6 years
Number Conservation	Ring Segment Conservation	Mass Conservation
Sibling Egocentrism	Class Inclusion	Length Conservation
Guessing Game	Transitivity	Sex Identity
Object Sorting		Generic Identity
		Magic
		Dream
		Left-Right Perspective
High-IQ, MA=7-2 years		Low-IQ, MA=6-5 years
Mass Conservation	Guessing Game	Sex Identity
Number Conservation	Length Conservation	Magic
Sibling Egocentrism	Generic Identity	Left-Right Perspective
Liquid Conservation	Length Transitivity	Sorting
Ring Segment Conservation		Class Inclusion
Dream		

TABLE 3 (Continued)

Tasks on which High-IQ group superior	Tasks on which High-IQ and Low-IQ groups are equivalent	Tasks on which Low-IQ group superior
High-IQ, MA=7-2 years		Low-IQ, MA=6-10 years
Sibling Egocentrism	Sex Identity	Mass Conservation
Length Transitivity	Generic Identity	Length Conservation
Number Conservation	Dream	Liquid Conservation
Ring Segment Conservation	Class Inclusion	Magic
		Left-Right Perspective
		Sorting
		Guessing Game
High-IQ, MA=8-2 years		Low-IQ, MA=7-11 years
Mass Conservation	Sorting	Left-Right Perspective
Number Conservation	Class Inclusion	
Length Conservation	Guessing Game	
Liquid Conservation		
Ring Segment Conservation		
Sex Identity		
Generic Identity		
Magic		
Dream		
Sibling Egocentrism		
Length Transitivity		

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